

A review of the Ascidiacea (Tunicata) of Moreton Bay, Queensland

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ABSTRACT

A review of the 95 species of the Ascidiacea recorded from Moreton Bay, Queensland shows that solitary species of Phlebobranchia and Stolidobranchia (53 species) dominate the fauna, there being few colonial species of either suborder and only 30 species of the almost exclusively colonial Aplousobranchia, eight being species of the Didemnidae recorded only from locations immediately to the north of the Bay rather than in its semi-enclosed waters. However, it is emphasised that much of the sampling within the Bay has been from muddy and sandy rather than hard substrates and this may have caused a bias in the material taken. An assessment of the geographic range of each of the species shows Moreton Bay to be the southern and northern limit for a number of species with, respectively, tropical and temperate affinities. This supports other studies indicating that Moreton Bay is at the centre of the eastern Australian tropical to temperate faunal transition zone. □ *Ascidiacea, Tunicata, Aplousobranchia, Phlebobranchia, Stolidobranchia, intertidal, subtidal, reef, taxonomy, checklist, biogeography.*

This study is based on the 4000 specimen lots of the Ascidiacea from Moreton Bay, and regions immediately to the north, registered in the collections of the Queensland Museum. Some hard surfaces are provided by several shipwrecks on Moreton I. and off the Gold Coast, reefs on the eastern side of the islands facing the Pacific Ocean, and rocky headlands such as Kings Beach (in the northern part of the Bay). Only a few locations are described as 'rocky reef' or 'Acropora reef'. However most ascidians were taken from habitats where sediments such as sand, mud and shell grit, and various mixtures of these, prevail. This may reflect a collecting bias that favours the large solitary species that dominate this species list. Many of the records are from dredge, grab and trawl collecting in connection with the late Prof. W. Stephenson's surveys of the benthic fauna (e.g. Stephenson *et al.* 1970, 1974, 1976). Colonial species that closely adhere to hard, clean substrates are not well sampled by these collecting methods; and usually settle on upper surfaces where fine sediments

could smother small colonial zooids with exposed branchial apertures opening on the upper surface of the colony.

TAXONOMIC NOTES

Ninety-five species of the Class Ascidiacea are represented in the collections from Moreton Bay, Caloundra and Flinders Reef (see Table 1). Their taxonomy is discussed in Kott (1972–2006).

Colonial species are known in the three sub-divisions (suborders) of the Ascidiacea. In one, Aplousobranchia, the colonial habit is almost universal, solitary species occurring only in rare and exceptional cases. In the Stolidobranchia about half of the higher level taxa (families and subfamilies) are colonial. In the Phlebobranchia, most species are large and solitary, only a couple of families being colonial. Colonies are formed by vegetative replication (budding or fission) that interrupts the growth of individuals and results in progressively smaller, more numerous, and more simplified zooids united by test. The parallel evolution of the colonial habit in each

suborder reflects a striking degree of convergence, all colonial taxa tending toward larger and more integrated colonial systems, and simplified body organs, especially reductions in the size of the ovary relative to the testis. This last condition, possibly associated with internal fertilisation and the liberation of embryos (brooded in the adult colony as free-swimming tailed larvae) is a strategy likely to contribute to population maintenance. It is one of the most significant aspects of the colonial habit in all suborders.

On the other hand, irrespective of suborder, most solitary species are externally fertilised and the adult body organs (branchial sac, gut and liver diverticulae and especially the gonads) tend to be larger and more elaborate, presumably to accommodate the needs of the large, solitary, externally fertilised individuals. However, although the colonial taxa present in Moreton Bay are in the minority, they can be placed in the same geographic groups (based on their known range) as the solitary taxa (see below). There are ecological reasons such as substrate and the range of habitats available that can explain the dominance of large solitary species in these waters, however there are no obvious biological reasons. Apart from the massive colonies of the stolidobranch *Polyandrocarpa colemani*, the colonial species most conspicuous in Moreton Bay are similar thin, sheet-like investing colonies irrespective of the suborders to which they belong, *viz.* Polyzoinae and Botryllinae (Stolidobranchia) and Didemnidae (Aplousobranchia). The characteristics of the suborders are summarised below and a Key to the families represented in Moreton Bay is given.

APLOUSOBRANCHIA

Twenty-nine species represent this exclusively colonial group. They have relatively small zooids with small branchial sacs, the gut loop in an abdomen behind the pharynx and a gonad of each sex either enclosed in the gut loop or stretched out behind it. Although they tend to have colony forms similar to some colonial Stolidobranchia, replication is even more prolific, usually resulting from segmentation of the zooids, the replicates developing from endodermal tissue in each segment. Only Clavelinidae are exceptional, their replicates being generated from mesodermal tissue in the terminal ampullae of the test vessels.

PHLEBOBRANCHIA

Thirteen of the species of Phlebobranchia are listed, characterised by their flat branchial sacs and single male and female gonads associated with the large gut loop embedded in the pallial body wall to the left of the branchial sac. Eleven species are large, solitary individuals with a firm, characteristically translucent gelatinous test; although in this collection there is an unusually large number of species (*Adagnesia opaca*, *Aguezia glaciata*, *Microgastra granosa* and *Ascidia scaevola*) with a thin test brittle with embedded sand that resembles the test of some *Polycarpa* and *Molgula* species (Stolidobranchia) and suggests that habitat requirements may be the principal environmental pressure selecting some components of the ascidian fauna of Moreton Bay. These species appear to be adapted for a benthic habitat on the sea floor, and the body muscles are modified to operate the closure of the apertures, rather than the general contraction of the body.

Two species are colonial (family Perophoridae), the small, replicated zooids joined by ectodermal stolons from which they develop, as they are added to the growing colony. Embryos generated from the ovaries in the gut loop in the left side of the atrial cavity are released into a brood pouch on the right. These are eventually liberated from the colony as free-swimming tailed larvae. This viviparous habit is characteristic of colonial ascidians in contrast to the oviparous externally fertilised habit of solitary species.

STOLIDOBRANCHIA

Stolidobranch species have the gut loop bent up into the pallial wall on either the right or the left side of the pharynx. One or more gonads are embedded in the pallial wall on both sides of the body. Branchial sacs are folded thus increasing the filtering area – a factor that is especially important in large solitary individuals.

Species usually have rough, leathery test, although in some, the body wall is closely adherent to the thin test which has sand embedded, making it rigid, brittle and non-contractile. Body muscles in these species tend to be adapted to the opening and closing of apertures rather than the contraction of the whole body wall. These adaptations are similar in a number of phlebobranch species, suggesting that these components of the ascidian fauna may be responding

to the same environmental pressures. The majority (41) of Stolidobranchia reported from Moreton Bay are solitary.

Colonial species of the Stolidobranchia (Styelidae) bud prolifically from ectodermal tissue of the pallial body wall or from vessels in the test in which they are embedded. These replicated zooids are small and simplified, the branchial sacs usually being reduced in size and in the number of folds (often being smooth), although they have gonads embedded in the body wall on each side of the pharynx as in solitary forms. In the present collection there are 10 colonial stolidobranch species, the majority being in the subfamily Botryllinae, which has similar encrusting colonies to the majority of the Aplousobranchia (Didemnidae) in this collection.

KEY TO FAMILIES OF ASCIDIACEA IN MORETON BAY

1. Gut in abdomen behind pharynx (Aplousobranchia) 2
 - Gut in body wall at the side of the pharynx. 8
2. Zooids develop from terminal ampullae of test vessels Clavelinidae
 - Zooids develop from horizontal subdivision of posterior abdomen and/or abdomen. 3
3. Gonads in posterior end of long gut loop. Polycitoridae
 - Gonads not in posterior end of long gut loop. 4
4. Testis in longitudinal series in posterior abdomen behind gut loop 5
 - Testis not in longitudinal series in posterior abdomen behind gut loop. 7
5. Excurrent openings of zooids exposed directly to exterior 6
 - Excurrent openings of zooids exposed to intracolony spaces. Polyclinidae
6. Larvae in brood pouch connected to anterior part of abdomen by narrow neck. Pseudodistomidae
 - Larvae develop in atrial cavity of zooids. Ritterellidae
7. Replicates develop as buds from oesophageal region of zooids. Didemnidae
 - Replicates develop by horizontal division of a posterior abdominal vegetative stolon. Holozoidae
8. Gonads on one side of body; branchial sac without folds. (Phlebobranchia) 9
 - Gonads on both sides of body; branchial sac folded. (Stolidobranchia) 12
9. Gonads enclosed in gut loop. 10
 - Gonads not enclosed in gut loop. Plurellidae
10. Small colonial zooids joined by external stolons from which they bud, and which fix them to the substrate; internally fertilised eggs develop in brood pouch on right side of pallial wall. Perophoridae
 - Large solitary externally fertilised individuals. 11
11. Stigmata coiled. Agneziidae
 - Stigmata rectangular. Ascidiidae
12. Branchial folds not more than four per side; branchial tentacles simple. Styelidae 13
 - Branchial folds more than four per side; branchial tentacles branched. 15
13. Solitary. Styelinae
 - Colonial. 14
14. Zooids not always completely embedded; excurrent apertures open separately to the exterior. Polyzoinae
 - Zooids always completely embedded; excurrent apertures open to an internal cavity. Botryllinae
15. Stigmata rectangular. Pyuridae
 - Stigmata coiled. Molgulidae

BIOGEOGRAPHY

Based on their known geographic range, the species presently recorded from Moreton Bay can be divided into five groups.

1. Cosmopolitan Species. These include in their geographic range the tropical Pacific, Atlantic and Indian Oceans, sometimes also the Mediterranean, and down the eastern and western coasts of Australia. Some (*Perophora multiclathrata* and *Styela canopus*) extend only to Moreton Bay or northern NSW on the eastern Australian coast, and Cockburn Sound or Bunbury on the Western Australian coast. *Trididemnum savignyi* is reported from the western and eastern coasts of Australia, and although pan-tropical is not known from north of the equator. *Microcosmus exasperatus* extends to Port Phillip Bay in the east and several species (*Botrylloides leachii*, *Botryllus schlosseri*

and *Diplosoma listerianum*) are recorded from all around the continent. *Molgula uanhatteusis* reported only for a limited time from the Brisbane River appears to have been introduced but never colonised in Australian waters (Kott 1972).

2. Indo-West Pacific Tropical Species. In Australian waters these have similar distribution patterns to cosmopolitan species, although *Phallusia arabica* has been recorded only from the Arafura Sea, the Great Barrier Reef and Moreton Bay. *Ritterella dispar* is known from the west Indian Ocean as well as the eastern Australian coast from Mackay to northern NSW. Otherwise it is not recorded from the Western Pacific nor from the western coast of Australia. The majority of species in this group have a known range extending south to Moreton Bay or northern New South Wales on the eastern coast and to Port Hedland, Shark Bay or Cockburn Sound on the western coast (*Polyclinum vasculosum*, *Didemnum uoseleyi*, *D. sordidum*, *D. menubrauceum*, *Lissodinium bistratum*, *Phallusia julinea*, *Eusystyela latericins*, *Microcosmus madagascariensis* and *M. squamiger*) although some have been recorded from all around the continent, including the southern coast (*Ascidia sydneyensis*, *Cnemidocarpa areolata*, *Polycarpa papillata*, *Polycarpa procera*, *Pyura gangeliou*, *P. sacciformis*, and *Botrylloides perspicuum*).

Lissoclium bistratum is of particular interest, being one of the characteristically tropical *Didemnum/Prochloron* symbioses (Kott 1980) which are autotrophic, the chlorophyll-containing Blue/Green algal symbionts photosynthesising carbohydrate to nourish the ascidians. The species is one of the tropical ascidians that extends furthest to the south, having been recorded also from Hastings Point (northern NSW).

3. Western Pacific Tropical Species. These occur in waters to the north of Australia, and many have a range extending down the eastern coast to Moreton Bay (*Distaplia dubia*, *Leptoclinides rufus*, *Polysyncraton meaudratnum*, *Ascidia eupheres*, *Herdmannia momus*, *Molgula diversa*) or to more southerly locations (*Eudistoma laysani*, *Ascidia scaevola*, *Microgastra granosa*). Also in this group *Microcosmus australis* extends south to Bass Strait on the eastern coast and Cockburn Sound on the west and *Molgula sphaera* to Moreton Bay and Albany on the eastern and western coasts, respectively; several species (*Polycarpa aurita*, *P.*

dinensis, *P. obscura*, *Botryllus tuberatus*) extend south to Moreton Bay and Cockburn Sound on the east and west, respectively); and some species have a range around the whole continent, including the southern coast (*Aplidium altarium*, *Cnemidocarpa pedata*, *Polycarpa argentata* and *Herdmannia graudis*).

4. Australian Species. These possibly indigenous species have not been recorded from outside Australian waters. They are either circum-Australian (*Ascidia latesiphonica*, *Phallusia obesa*, *Polycarpa pedunculata*); or known only from the northeastern and northwestern coasts (*Sigillina cyanea*, *Sycozoa pulchra*, *Synoicum macroglossum* and *Eugyra molguloides*). Also, the largest group of species reported from Moreton Bay are a group of 27 indigenous species known only from the eastern coast of the continent that are perhaps the best indicators of its biogeographic affinities. Some of these species are not recorded south of Moreton Bay and could be regarded as tropical species (*Didemnum scopi*, *Lissoclium condylium*, *Phallusia barbarica*, *Cnemidocarpa floccosa*, *C. stolonifera*, *Polycarpa fungiformis*, *P. nota*, *P. ovata*, *Pyura coufragosa*). Some not recorded north of Moreton Bay may very likely have temperate affinities (*Clavelina australis*, *Pseudodistoma inflatum*, *Aplidium directum*, *Dunus areniferus*, *Adagnesia opaca*, *Stolonica australis*, *Microcosmus propinquus*, *Parengyrioides exigua*). *Trididemnum cerebriforme*, known from the central coast of Western Australia, the southern coast of the continent and north to Moreton Bay and also may have temperate affinities. Five species (*Aplidium incubatum*, *Leptoclinides longicollis*, *Polysyncraton flammeum*, *Perophora sabulosa* and *Molgula rima*) have been recorded only from the immediate vicinity of Moreton Bay.

Only seven species, *Leptoclinides placidus* (Noosa to northern NSW), *Eudistoma elongatum* (Hervey Bay to Port Jackson), *Synoicum prunum* (Cape Tribulation to NSW), *Ascidia decepta* (Townsville to South Australia), *Ascidia glabra* (Townsville to NSW), *Hartmeyera formosa* (Torres Strait to Bass Strait) and *Microcosmus stoloniferus* (Innisfail to South Australia) do not have a boundary at Moreton Bay and there is no indication of biogeographic affinity from the data presently available.

5. Southern Ocean Species. These form only a relatively small component, and include: *Agnesia glaciata*

(reported from subantarctic locations, extending up the South American and Australian (to Double Island Point, SE Qld) continents, and *Pyura stolonifera* (which may be a Gondwanaland relict, having populations on the coasts of Africa, the south-eastern coast of Australia and in Peru, Ecuador and Chile); *Botryllus stewartensis* and *Diumus areuiferus* (extending across the southern Australian coast); and *Sigillina cyanea* (reported from south eastern and western Australia) are known from New Zealand and appear to have a Trans-Tasman connection (Kott 2007a).

CONCLUSION

The semi-enclosed embayment that is Moreton Bay, appears to be a transition zone between the tropical and temperate species of the eastern coast of Australia. Thirty two species with tropical affinities and with the southern limits of their range at Moreton Bay dominate the fauna. The majority of these are large, solitary

species. Another (albeit smaller but well-defined) group of 14 species are judged to be temperate, having the northern limits of their range in Moreton Bay. Seven species appear to be indigenous to the central eastern coast of Australia, and there are five species known only from Moreton Bay and its immediate vicinity. Other species recorded from the area have a wide pan-tropical, tropical Indo-West Pacific, western Pacific and circum-Australian range that include Moreton Bay and extend into temperate waters down the eastern and western coasts of Australia.

Relatively few colonial species are known from the area and these are most often similar thin sheet-like colony forms. The composition of the ascidian fauna may be the result of the lack of habitats favouring a colonial habit while large solitary phlebobranch and stolidobranch species are well adapted for the mud, shell and sand substrates that abound in the area.

Table 1. List of species of the Class Ascidiacea reported from Moreton Bay, Queensland. Each family heading includes a citation to a recent account of species-level taxa for that family (see also Kott 2005).

Species	Locality	Depth/Collecting method/ Substrate
APLOUSOBRANCHIA		
Family Clavelinidae [see Kott 1990a]		
<i>Clavelina australis</i> (Herdman, 1899)	North Stradbroke I. (Amity Point 18.2 km W of Myora); Peel I.	to 9m dredge sides of rocky reef
Family Polycitoridae [see Kott 1990a, 1992b]		
<i>Eudistoma elougatum</i> (Herdman, 1886)	Gold Coast Seaway (piles outside Seaworld); North Stradbroke I. (Dunwich, intertidal flats, Amity Point, Myora); Myora Light (c. 2.4 km N); Moreton I.; Bribie I. (Pumice Stone Passage); Redland Bay (in landing strip area, c. 1.6 km offshore); Jacobs Well Jetty; Biggera Creek (1 km from mouth of creek. L.W.M.); Caloundra (Kings Beach)	intertidal trawl dredge mud flats with <i>Zostera</i> sp.; sea grass meadows; dolorite rock, behind ridge, deep ledge; boat jetty pile; rocky substrate
<i>Eudistoma laysanii</i> (Sluiter, 1900)	North Stradbroke I. (Dunwich; Myora Banks); Caloundra (Moffat Beach)	3–30 m common under rocks
Family Holozoidae [see Kott 1990a]		
<i>Sycozoa pulchra</i> (Herdman, 1886)	Coochiemudlo I. (1.6 km NE.); 0.8–1.6 km S of Peel I. (Southwest Rocks); 2 km N of Hope Beacon; Redland Bay (between mainland & Garden I.)	2–10 m trawl, dredge mud through to sand and shell grit
Family Pseudistomidae [see Kott 1992a, 2007a]		
<i>Pseudodistoma inflatum</i> Kott, 1992a	Mooloolaba (Gneering Shoals)	
<i>Sigillina cyanea</i> (Herdman, 1899)	Moreton I. (Tangalooma wrecks)	

Species	Locality	Depth/Collecting method/ Substrate
Family Ritterellidae [see Kott 1992a]		
<i>Dumus areniferus</i> Brewin, 1952	North Stradbroke I. (Dunwich); Moreton I.	10 m dredge; rocky substrate
<i>Ritterella dispar</i> Kott, 1957	Moreton I.; Caloundra; Flinders Reef	
Family Polyclinidae [see Kott 1992a]		
<i>Aplidium altarium</i> (Sluiter, 1909)	North Stradbroke I. (Myora Banks)	
<i>Aplidium directum</i> Kott, 1972	North Stradbroke I. (Dunwich); Cape Moreton	6--140 m dredge; coral rubble
<i>Aplidium incubatum</i> Kott, 1992a	Cape Moreton, Point Lookout, Smith's Rock	intertidal to 10 m; coral rubble; crevices in rocky platforms
<i>Aplidium</i> sp.	North Stradbroke I. (Dunwich); Moreton I. (Smith's Reef)	15 m dredge
<i>Polyclinum vasculosum</i> Pizon, 1908	North Stradbroke I. (Myora Banks); Bribie I. (Pumicestone Passage)	Deep ledge, behind ridge
<i>Synoicum macroglossum</i> (Hartmeyer, 1919)	Gold Coast (Scottish Prince)	13 m wreck dive
<i>Synoicum prunum</i> (Herdman, 1899)	Bribie I. (Ocean Beach)	
Family Didemnidae [see Kott 2001]		
<i>Didemnum jedanense</i> Sluiter, 1909	Cowan Cowan Wrecks	1.8 m coral rubble
<i>Didemnum membranaceum</i> Sluiter, 1909	Moreton I.; Caloundra	5 m under ledge
<i>Didemnum moseleyi</i> (Herdman, 1886)	Caloundra	1 m under buoy
<i>Didemnum scopi</i> Kott, 2001	Caloundra (Kings Beach)	intertidal rocky substrate
<i>Didemnum sordidum</i> Kott, 2001	Moreton I.	5 m under ledge
<i>Diplosoma listerianum</i> (Milne Edwards, 1841)	North Stradbroke I. (Myora Banks); Woody Point	on back of crab
<i>Leptoclinides longicollis</i> Kott, 2001	Moreton Bay	
<i>Leptoclinides placidus</i> Kott, 2001	Moreton I. (Smith Rock)	15 m
<i>Leptoclinides rufus</i> (Sluiter, 1909)	Caloundra (King's Beach)	intertidal rocky substrate
<i>Lissoclinium bistratum</i> (Sluiter, 1905)	off Moreton Island (Smith Rock); Flinders Reef	15 m coral reef
<i>Lissoclinium conchylum</i> Kott, 2001	Moreton I.	6 m under rock
<i>Polysyncraton flammeum</i> Kott, 2001	Caloundra (King's Beach)	
<i>Polysyncraton meandratum</i> Monniot, 1993	Caloundra (King's Beach)	intertidal rocky substrate

Ascidiacea of Moreton Bay

Species	Locality	Depth/Collecting method/ Substrate
<i>Trididemnum nobile</i> Kott, 2001	N Stradbroke I. (W of Myora, coral bay); Caloundra (King's Beach)	13–15 m, intertidal reef, rocky substrate
<i>Trididemnum savignyi</i> (Herdman, 1886)	Moreton I. (Smith's Rock)	15 m reef
PHLEBOBRANCHIA		
Family Agneziidae [see Kott 1985]		
<i>Adagnesia opaca</i> Kott, 1963	Toorbul Point (0.8 SE Red Beacon); Peel I. (Southwest Rocks); Rous Channel	5–10 m sand, shell, grit
<i>Agnezia glaciata</i> (Michaelsen, 1898)	North Stradbroke I. (Dunwich); Peel I. (Southwest Rocks)	2–17 m sand and mud
Family Ascidiidae [see Kott 1985, 2003]		
<i>Ascidia decepta</i> Kott, 1985	North Stradbroke I. (Dunwich); Biggera Ck (1 km from mouth of creek); Cleveland Point; Redcliffe (Woody Point)	intertidal
<i>Ascidia eupheres</i> Sluiter, 1895	North Stradbroke I. (Dunwich): Victoria Point	
<i>Ascidia glabra</i> Hartmeyer, 1922	North Stradbroke I. (Myora Banks); Peel I.	
<i>Ascidia latesiphonica</i> Hartmeyer, 1922	Moreton I (The Wrecks); Victoria Point	10 m
<i>Ascidia scaevola</i> (Sluiter, 1904)	Peel I; 08- 1.6 km S of Peel I. (Southwest Rocks); 2.4 km SE St Helena; Green I. (S beacon on N tip); W of Hope Banks; Cleveland (N pt of Green I. on Nazereth House	2–9 m grab, dredge sand, shell, grit, mud, sandy mud
<i>Ascidia sydneyensis</i> Stimpson, 1885	North Stradbroke I. (Dunwich, Myora Banks); Peel I. (between two beacons, Southwest Rocks); 0.8- 1.6 km S of Peel I. (Southwest Rocks); St. Helena I. (2.4 km E); Wellington Point (3.2 km E); Redcliffe: Otter Rock (1.6 km E)	intertidal, 2–8 m trawl, grab, dredge various mixtures of sand, shell, grit, mud; coral; mud flats with <i>Zostera</i> sp.
<i>Phallusia arabica</i> Savigny, 1816	North Stradbroke I. (Dunwich)	intertidal
<i>Phallusia barbarica</i> Kott, 1985	Cleveland Point	rocks and mud
<i>Phallusia julinea</i> Sluiter, 1915	North Stradbroke I. (Myora Banks, Dunwich); Moreton I. (Cowan Cowan)	to 20 m
<i>Phallusia obesa</i> (Herdman, 1880)	Moreton I. (Cowan Cowan Wrecks)	20 m
Family Perophoridae [Kott 1985, 1990b, 1992b]		
<i>Perophora multiclathrata</i> (Sluiter, 1904)	Redcliffe (Woody Point)	
<i>Perophora sabulosa</i> Kott, 1990	North Stradbroke I. (Pt Lookout, Dunwich); Peel I.	intertidal, 6 m dredge, rock crevices
Family Plurellidae [Kott 1985, 1990b]		
<i>Microgastra granosa</i> (Sluiter, 1904)	North Stradbroke I. (Dunwich); Peel I.	dredge
STOLIDOBRANCHIA		
Family Styelidae (Styelinae) [Kott 1985, 1992b, 2003]		
<i>Cnemidocarpa areolata</i> (Heller, 1878)	off Moreton I. (Smiths Rock); Caloundra (Shelly Beach)	15 m muddy sand

Species	Locality	Depth/Collecting method/ Substrate
<i>Cnenuidocarpa floccosa</i> (Sluiter, 1904)	0.8–1.6 km S of Peel I. (Southwest Rocks); Bramble Bay (5 km NE Cabbage tree); Brisbane River mouth	2–9 m
<i>Cnenuidocarpa lobata</i> (Kott, 1952)	Gold Coast (wreck of Scottish Prince)	13 m wreck dive
<i>Cnenuidocarpa pedata</i> (Herdman, 1881)	Trawled with <i>Pyura spinifera</i>	trawl
<i>Cnenuidocarpa stolonifera</i> (Herdman, 1899)	North Stradbroke I. (Rainbow Channel, Dunwich, Amity Point, Myora Light); 0.8–1.6 km S of Peel I. (Southwest Rocks); Peel I.; Moreton I. (Smith Rock, Cowan Cowan wreck); off Moreton Island; St Helena I. (S); Redcliffe Jetty (1.6 km SE); Redcliffe Water Tower (E, 1.6 km offshore); southern Moreton Bay (W side)	4–15 m trawl, dredge, grab mud, shell, grit, sandy mud; sand slope out from boat ramp, mud flats, fringing reef; <i>Acropora</i> reef
<i>Polycarpa argentata</i> (Sluiter, 1890)	Moreton I. (Smith Rock)	15 m
<i>Polycarpa aurita</i> (Sluiter, 1890)	North Stradbroke I. (Dunwich); 0.8–1.6 km S of Peel I. (Southwest Rocks); Raby Bay	intertidal to 9 m; grab sand, shell, grit, shelly sand, sandy mud
<i>Polycarpa chinensis</i> (Tokioaka, 1967)	Moreton I. (Tangalooma, 8 km W, nr M3 beacon; S edge Dring Banks; 0.8–1.6 km S of Peel I. (Southwest Rocks); 6.4 km off North Stradbroke I.; W of Hope Banks, Scarborough (8.7 km E of Reef Pt; 12.8 km E); Scarborough	7–12 m on rising shallowing banks grab, trawl, dredge mud, sand, shell, grit;
<i>Polycarpa fungiformis</i> Herdman, 1899	North Stradbroke I. (Dunwich); Southern Moreton Bay, W side); 0.8–1.6 km S of Peel I. (Southwest Rocks)	5–8 m grab, trawl, dredge muddy, gritty mud, sand, shell grit
<i>Polycarpa nota</i> Kott, 1985	North Stradbroke I. (Myora Banks)	
<i>Polycarpa obscura</i> Heller, 1878	Moreton I. (Cowan Cowan wrecks)	20 m
<i>Polycarpa ovata</i> Pizon, 1908	Myora Light (45.7 m W); Mud I.; Peel I.; Redcliffe Water Tower (1.6 km E)	intertidal–10 m; dredge, grab mud to sand and shell grit
<i>Polycarpa papillata</i> (Sluiter, 1885)	Gold Coast (Scottish Prince, Bait Reef); N. Stradbroke I. (Myora Light, Dunwich); Peel I.; Hope Banks (1.6 km E); Moreton I. (Cowan Cowan); 2.1 km SW Wellington Point (3.2 km E); St Helena I. (0.8 km E and S beacon off Green I. 2.4 km E); Mud I. Redcliffe Jetty (1.6 km SE); Flinders Reef; Hutchison Shoals	10–20 m trawl, dredge, SCUBA amongst reef corals, sponges, mussels, sand to mud and shell-grit substrates; sides of rocky reef, <i>Acropora</i> reef
<i>Polycarpa pedunculata</i> Heller, 1878	Moreton I. (Cowan Cowan); Scarborough (183 m off blinker)	3–20 m dredge, wreck dives
<i>Polycarpa procera</i> (Sluiter, 1885)	Moreton I.	sides of rocky reef
<i>Styela canopus</i> (Savigny, 1816)	North Stradbroke I. (Dunwich); Peel I. east (Hanlon Light); Pearl Channel (6.4 km NE of Pearl Channel buoy); Wellington Point)	3–7 m dredge gritty sand with mud
<i>Styela plicata</i> (Lesueur, 1823)	Peel I. (Southwest Rocks); Manly Boat Harbour; Wellington Point; Biggera Ck (1 km from mouth of creek on large boulders)	3–7 m intertidal grab sand, shell, grit; sandy mud;

Ascidiacea of Moreton Bay

Species	Locality	Depth/Collecting method/ Substrate
Family Styelidae (Polyzoinae) [Kott 1985, 1990b, 1992b]		
<i>Eusynstyela latericius</i> (Sluiter, 1904)	Moreton I.; Biggera Creek (1 km from mouth of creek)	under rock
<i>Polyandrocarpa colemani</i> Kott, 1992	Gold Coast (Scottish Prince)	13 m wreck dive
<i>Stolonica australis</i> Michaelsen, 1927	North Stradbroke I. (Dunwich); Peel I.	dredge
<i>Symplegma brakenhielmi</i> (Michaelsen, 1904)	North Stradbroke I. (Dunwich, Myora Banks); Moreton I. (Cowan Cowan); Cleveland Point (3.2 km NNE); Hutchinson Shoals	20 m under rock, on wreck, mud flats with <i>Zostera</i> , gritty mud
<i>Metandrocarpa miniscula</i> Kott, 1985	North Stradbroke I. (Point Lookout)	sand-adapted in crevices and epibiotic; intertidal
Family Styelidae (Botryllinae) [Kott 1985, 1990b, 1992b]		
<i>Botrylloides leachii</i> (Savigny, 1816)	Pearl Channel (6.4 km NE of Pearl I.)	1.9 m; grab, wreck dive; sand, shell, grit, gritty mud, intertidal pools in mud flats
<i>Botrylloides perspicuum</i> Herdman, 1886	Moreton I. (The Pines); Coffee Rock	14 m sides of rocky reef
<i>Botrylloides violaceus</i> Oka, 1927	Gold Coast (Scottish Prince); Moreton I.	13 m; on wreck; mud flats, sandy mud and fringing reef
<i>Botryllus schlosseri</i> (Pallas, 1766)	North Stradbroke I. (Myora Light, Myora Banks); Peel I (S)	dredge
<i>Botryllus stewartensis</i> Brewin, 1858	North Stradbroke I. (Point Lookout)	intertidal to 10 m coral rubble, low tide crevices
<i>Botryllus tuberculatus</i> Ritter & Forsyth, 1917	North Stradbroke I. (Myora Banks)	
Family Pyuridae [Kott 1985, 1990b, 2002]		
<i>Hartmeyeria formosa</i> Herdman, 1881	Peel I. (Southwest Rocks); Bramble Bay (5 km NE Cabbage Tree); Hope Banks (3.2 km W)	5-12 m; grab, dredge sand, shell grit, mud, sandy mud, muddy sand
<i>Herdmania grandis</i> (Heller, 1878)	North Stradbroke I. (6.4 km off); Moreton I. (Smith Rock); Cleveland Light; halfway between Cleveland and Peel I. jetties; Redcliffe Water Tower (1.6 km offshore)	5-15 m trawl muddy grit, gritty sandy mud, shelly, mud and shell
<i>Herdmania momus</i> (Savigny, 1816)	Flinders Reef	5.4-9 m gritty mud, coral reef
<i>Microcosmus australis</i> Herdman, 1899	North Stradbroke I. (Myora Banks); Moreton I. ('The Wrecks'); 0.8 km south of Peel I. (Southwest Rocks); Scarborough to Bribie I.; Otter Rock (1.6 km E); Biggera Ck (1 km from mouth of ck, on large boulders); Bramble Bay (5 km NE Cabbage Tree)	1.8-8.3 m; low tide dredge, grab mud with shell; shell, grit; shelly; gritty mud, clean and hard sand
<i>Microcosmus exasperatus</i> Heller, 1878	North Stradbroke I. (Dunwich, Myora Banks); Southwest Rocks, 0.8 km S of Peel I.; Peel I.; Brisbane River mouth; Cleveland (Raby Bay)	6.5 m; grab, dredge; mud flats and rubble with hard and soft corals; mud flats and <i>Zostera</i>
<i>Microcosmus madagascariensis</i> Michaelsen, 1918	Moreton Bay	6 m dredged
<i>Microcosmus propinquus</i> Herdman, 1881	1.6 km S of Peel I. (Southwest Rocks)	5.4 m grab; sandy mud

Species	Locality	Depth/Collecting method/ Substrate
<i>Microcosmus squamiger</i> Michaelsen, 1927	North Stradbroke I. (Dunwich, Myora Banks); 0.8 km S of Peel I. (Southwest Rocks); Brisbane River mouth; Biggera Ck (1 km from mouth of ck on large boulders); Cleveland Point; Redcliffe Peninsula (Woody Point)	intertidal, 7.6 m grab, dredge sand, shell, grit; on rocky shore; from Mussel clumps, under rocks LWM
<i>Microcosmus stoloniferus</i> Kott, 1952	Peel I.; 0.8–1.6 km S of Peel I. (Southwest Rocks)	5.4–7.9 m; grab, dredge; mud to sand, shell and grit
<i>Pyura coufragosa</i> Kott, 1985	off Moreton I. (Smith Rock)	15 m rocky reef
<i>Pyura elongata</i> Tokioka, 1952	North Stradbroke I. (Dunwich); Peel I.; Cleveland Point, Wellington Point Jetty	intertidal dredge; on rocks
<i>Pyura gangelion</i> (Savigny, 1816)	Moreton I. (Tangalooma); Peel I. (S end between 2 beacons; W end: 1.6 km S Southwest Rocks); Peel I. (S of Myora Banks)	2.1–5.4 m dredge, grab; muddy grit, shell grit sandy mud, wrecks
<i>Pyura navicula</i> Kott, 1985	Moreton I. (Cowan Cowan)	20 m
<i>Pyura sacciformis</i> (Drasche, 1884)	Moreton I. (Cowan Cowan Wrecks)	18 m encrusting epifauna off wreck
<i>Pyura stolonifera</i> (Heller, 1878)	Gold Coast Seaway; North Stradbroke I. (Amity Point); Moreton I. (Cowan Cowan, Smith Rock); Caloundra (Shelly Beach)	1–20 m on piles, rock wall
Family Molgulidae [Kott 1985]		
<i>Eugyra molguloides</i> Sluiter, 1904	Peel I.; 0.8–1.6 km S of Peel I. (Southwest Rocks); Bramble Bay (5 km NE Cabbage Tree)	3.5–8 m dredge, grab sandy mud; gritty mud
<i>Molgula diversa</i> Kott, 1972	1.6 km S of Peel I. (Southwest Rocks)	6–10 m sand, shell, grit, sandy mud;
<i>Molgula ficus</i> (Macdonald, 1859)	North Stradbroke I. (Dunwich); Redland Bay (landing strip area); Sandgate Jetty; Naval Reserve (4.8 km N); Bramble Bay (5 km NE Cabbage Tree); Brisbane River mouth; Biggera Creek (1 km from mouth of creek); Scarborough (8.7 km E of Reef Point); Cleveland Point; Woody Point	LWM to 10 m grab, dredge, trawl sand, shell, mud, grit, gritty mud, sandy mud
<i>Molgula manhattensis</i> (de Kay, 1843)	Brisbane River (Mobray Park, mouth of Norman Creek, Bulimba Corner, City Reach)	mid-channel
<i>Molgula mollis</i> Herdman, 1899	Brisbane River mouth	
<i>Molgula rima</i> Kott, 1972	Peel I. (Southwest Rocks)	6–10 m; grab, dredge sand to mud, and shell grit
<i>Molgula sphaera</i> Kott, 1972	Peel I. (Southwest Rocks)	3–7 m; grab sand to mud, and shell grit
<i>Pareugyrioides exigua</i> (Kott, 1972)	1.6 km S of Peel I. (Southwest Rocks)	6–10 m sand, sandy mud, shell, grit

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